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2003

## Cost Engineering and Cost Engineering part 2

Beach, Jeff

Monterey, California: Naval Postgraduate School

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# The Product Oriented Design and Construction (PODAC) Cost Model



A Proposed Procedure for Product-Based  
and Process-Driven Ship Cost Estimating

# The (new) Standard Procedure



## **1. Define the Product to be Built (Mandatory)**

- 1.1. Define the item for which an estimate is required.
- 1.2. Determine the Product Work Breakdown Structure for the item.

## **2. Define How the Product will be Built (Mandatory.)**

- 2.1. Determine the Work Types.
- 2.2. Determine the Stages of Construction.
- 2.3. Determine the Work Centers.
- 2.4. Determine the Cost Items
- 2.5. Determine the unit of measure for each Cost Item.
- 2.6. Determine the direct labor hours per unit of measure, or the total direct labor hours, for each Cost Item.
- 2.7. Determine the material cost per unit of measure, or the total material cost, for each Cost Item.

## **3. Define the Cost Information (Mandatory)**

- 3.1. Determine the direct labor rates.

The standard procedure has five steps; three set up the problem.

# The Standard Procedure (Continued)



## **4. Estimate the Cost of the Baseline Product (Mandatory)**

- 4.1. View by Project Summary
- 4.2. View by PWBS Summary
- 4.3. View by Work Center Summary
- 4.4. View by Paragraph Summary
- 4.5. View by Cost Item Value by Work Center
- 4.6. View by Cost Item Value by PWBS

The standard procedure has five steps; one provides the cost estimate.

# The Standard Procedure (Continued)

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## **5. Perform Studies on the Baseline Cost Estimate (Optional)**

### 5.1. Builder Variations

- 5.1.1. Modify Work Center labor cost rates and cost rate application equations
- 5.1.2. Modify overhead cost rates and profit margin
- 5.1.3. Move selected Cost Items from one Work Center to another
- 5.1.4. Changing selected Cost Items from one rate year to another

### 5.2. Product Variations

- 5.2.1. Modify the Cost Item cost data
- 5.2.2. Modifying labor-hour estimates, labor costs, or material costs
- 5.2.3. Deleting selected Cost Items
- 5.2.4. Replacing selected sets of Cost Items with other sets

### 5.3. Process Variations

- 5.3.1. Modify the Cost Item cost data
- 5.3.2. Modifying labor-hour estimates, labor costs, or material costs
- 5.3.3. Changing selected Cost Items from one rate year to another
- 5.3.4. Deleting selected Cost Items
- 5.3.5. Replacing selected sets of Cost Items with other sets

The standard procedure has five steps; one provides trade-off opportunities.

# New Thinking:

## 1. Define the Product to be Built (Mandatory)

- 1.1. Define the item for which an estimate is required.
- 1.2. Determine the Product Work Breakdown Structure for the item.



## 2. Define How the Product will be Built (Mandatory.)

- 2.1. Determine the Work Types.
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## 3. Define the Cost Information (Mandatory)

- 3.1. Determine the direct labor rates.

These items are new to us.

# Unit Price Analysis (UPA) Cost Model vs PODAC Cost Model



⌘ UPA is systems-based...PODAC is product-based

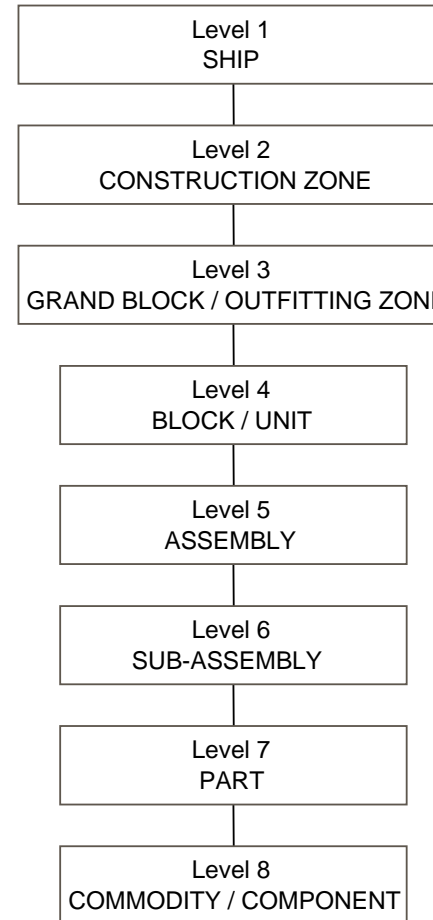
⌘ UPA is weight-driven...PODAC is process-driven

# System-Based to Product-Based

Extended  
Ship  
Work  
Breakdown  
Structure

ESWBS

100	Hull Structure
200	Propulsion
300	Electric Plant
400	Command & Surveillance
500	Auxiliary Systems
600	Outfit & Furnishings
700	Armament
800	Integration/ Engineering
900	Ship Assemble & Support Services



Generic  
Product  
Work  
Breakdown  
Structure

G/PWBS


The PODAC Cost Model uses a different cost accounting system.



# Weight-Driven to Process-Driven

UPA CM

PODAC CM

Labor CER = Hours / Ton  = f ( Process ) = g ( Interim Product, Stage, Work Type )

This is different.

Material CER = \$ / Ton  = ( \$ / Unit of Measure )<sub>Interim Product</sub>

This is the “same.”

where Hours, Ton, and \$ are known via normal bid proposals or cost reporting and ship weight reports.

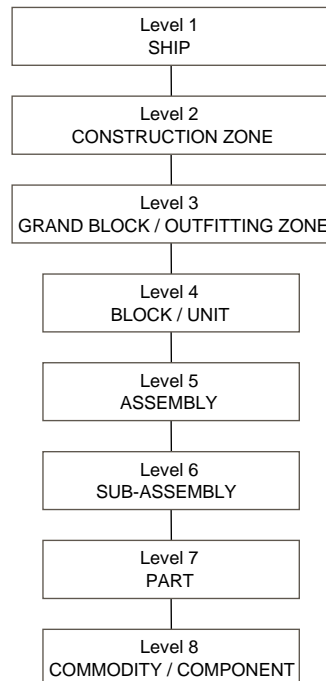
where Interim Product, Stage, and Work Type are known to the shipyard, but (generally) unknown to the Navy cost estimator.

The major difference between the two models is the labor CER since the Unit of Measure could be Tons.

# Consider the Labor CER

⌘ Labor CER = f (Process) = g (Interim Product, Stage, Work Type)

⌘ Interim Product



⌘ Stage

Non-Construction Related	Construction Related
Designing Planning Procurement Purchasing Material Management Launch Delivery Post Delivery Test & Trials	Fabricating Sub-Assembling Assembly On-Unit Outfitting On-Block Outfitting Grand Block Construction Erecting On-Board Outfitting  Set-Up Clean-Up Finishing

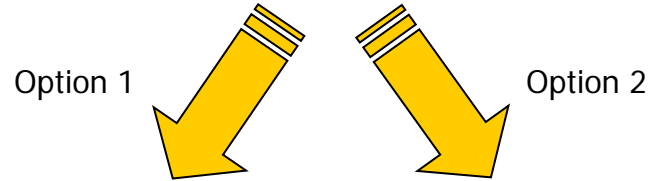
⌘ Work Type

Administration Engineering Hull Outfitting HVAC Joiner Materials Machinery Material Handling Operations Control Paint Pipe Production Services Quality Assurance Structure Test & Trials Unit Construction
---

Labor CERs are a function of what type of work is being performed on what product, when and where.

# Generating the Labor CER

⌘ Labor CER = f (Process) = g (Interim Product, Stage, Work Type)



Shipyard(s) Developed

- Historical records
- Code of Accounts

Navy Developed

- NSRP
- Experts
- Etc.

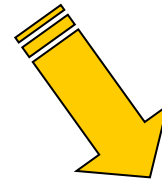
There are two options for generating CERs; they are not mutually exclusive options.

# Consider Navy Developed Labor CERs

⌘ Labor CER = f (Process) = g (Interim Product, Stage, Work Type)

The CER development procedure is based on work documented in:

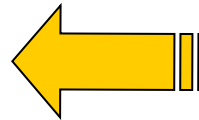
- NSRP Paper 0405, "Development of Producibility Evaluation Criteria," (Dec 1993).
- NSRP Paper 0398, " Producibility Evaluation Criteria Cost Estimating Computer Programs - Manuals," (Dec 1993).
- Berentine, LCdr John, "A Process-Based Cost Estimating Tool for Ship Structural Design," (May 1996).



Option 2

Navy Developed

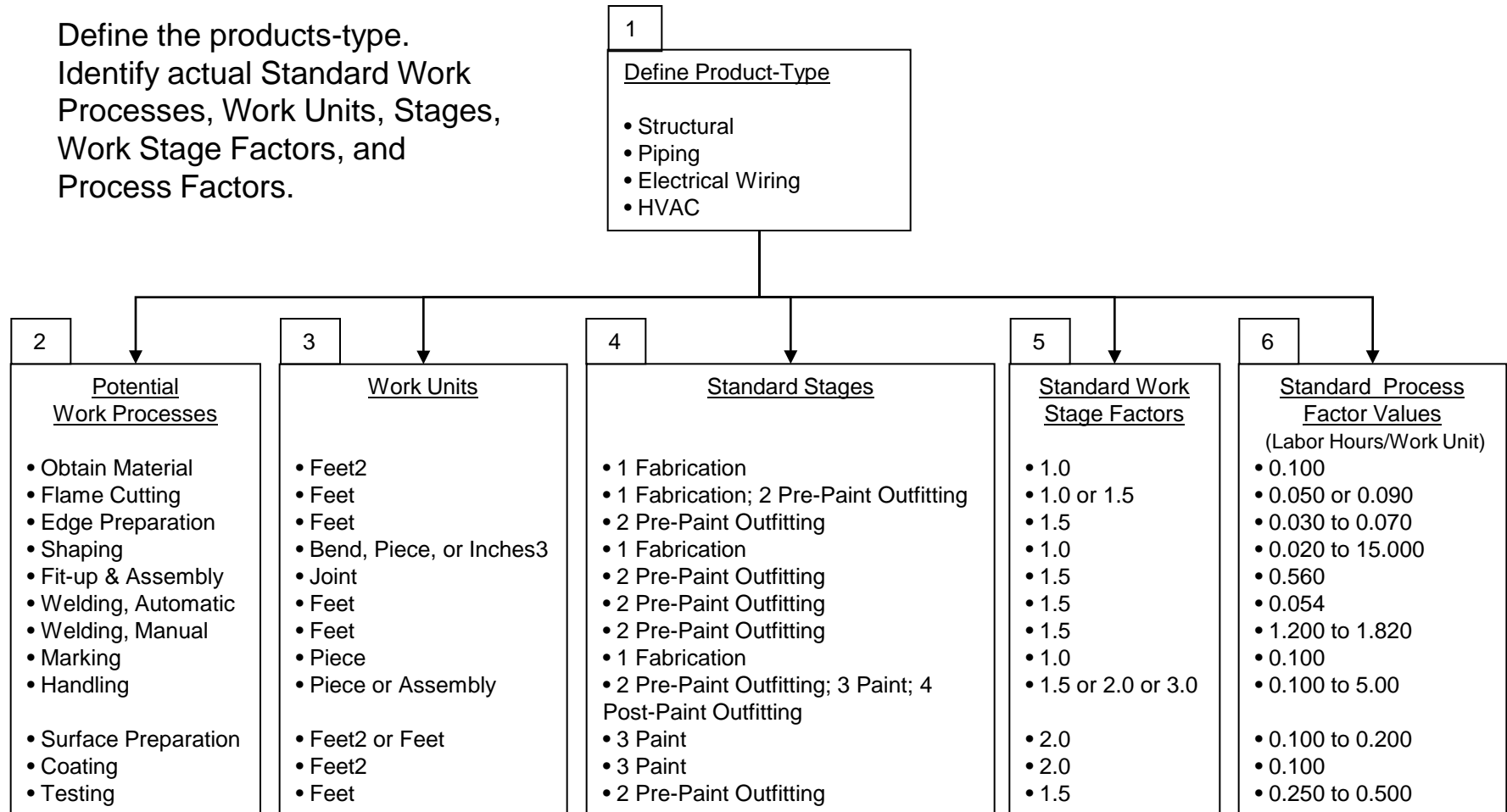
- NSRP
- Experts
- Etc.



We relied heavily on the work of others.

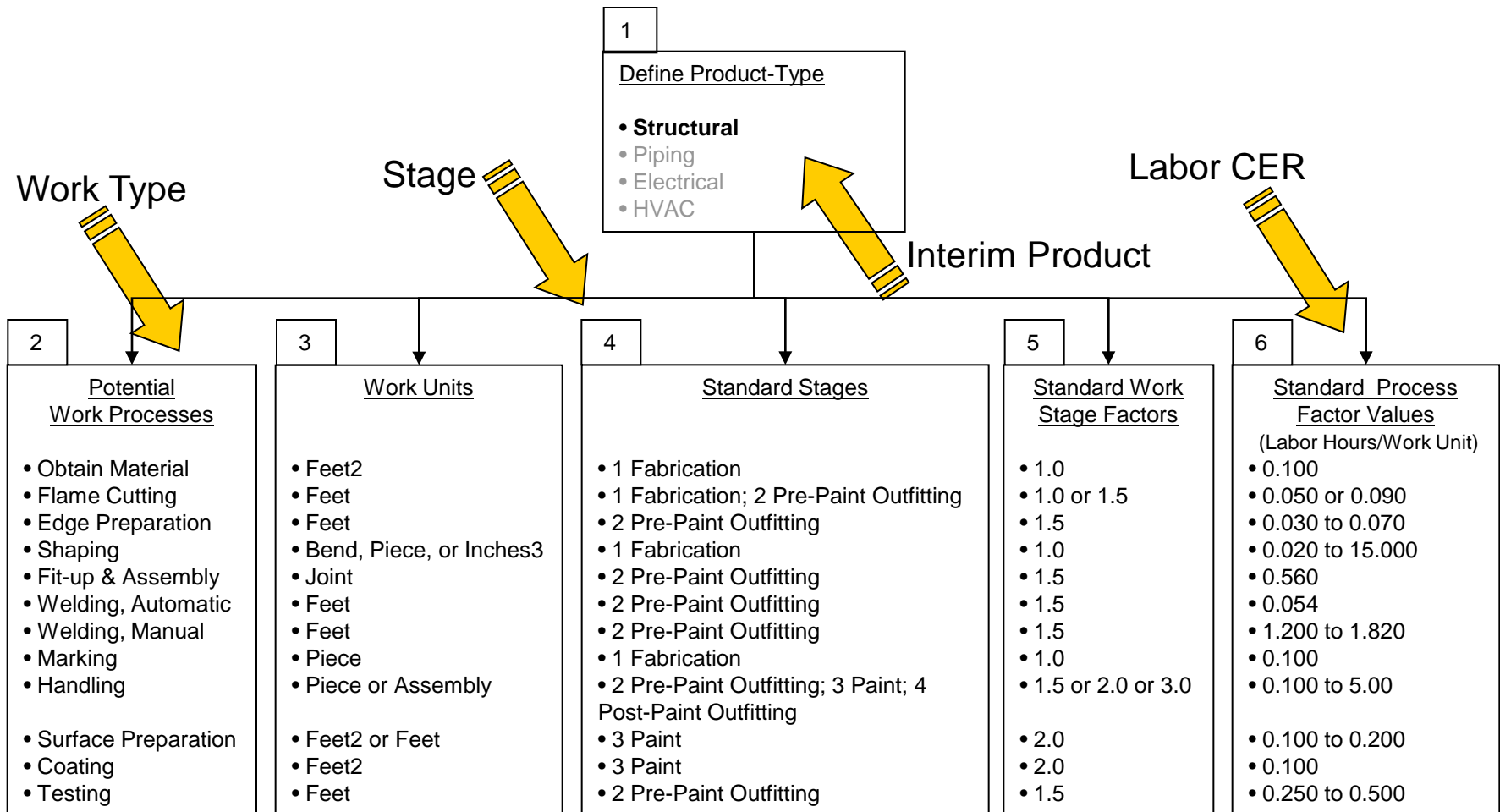
# The Procedure for Generating Product CERs

Define the products-type.  
Identify actual Standard Work Processes, Work Units, Stages, Work Stage Factors, and Process Factors.



The procedure has thirteen steps; the first six are generic.

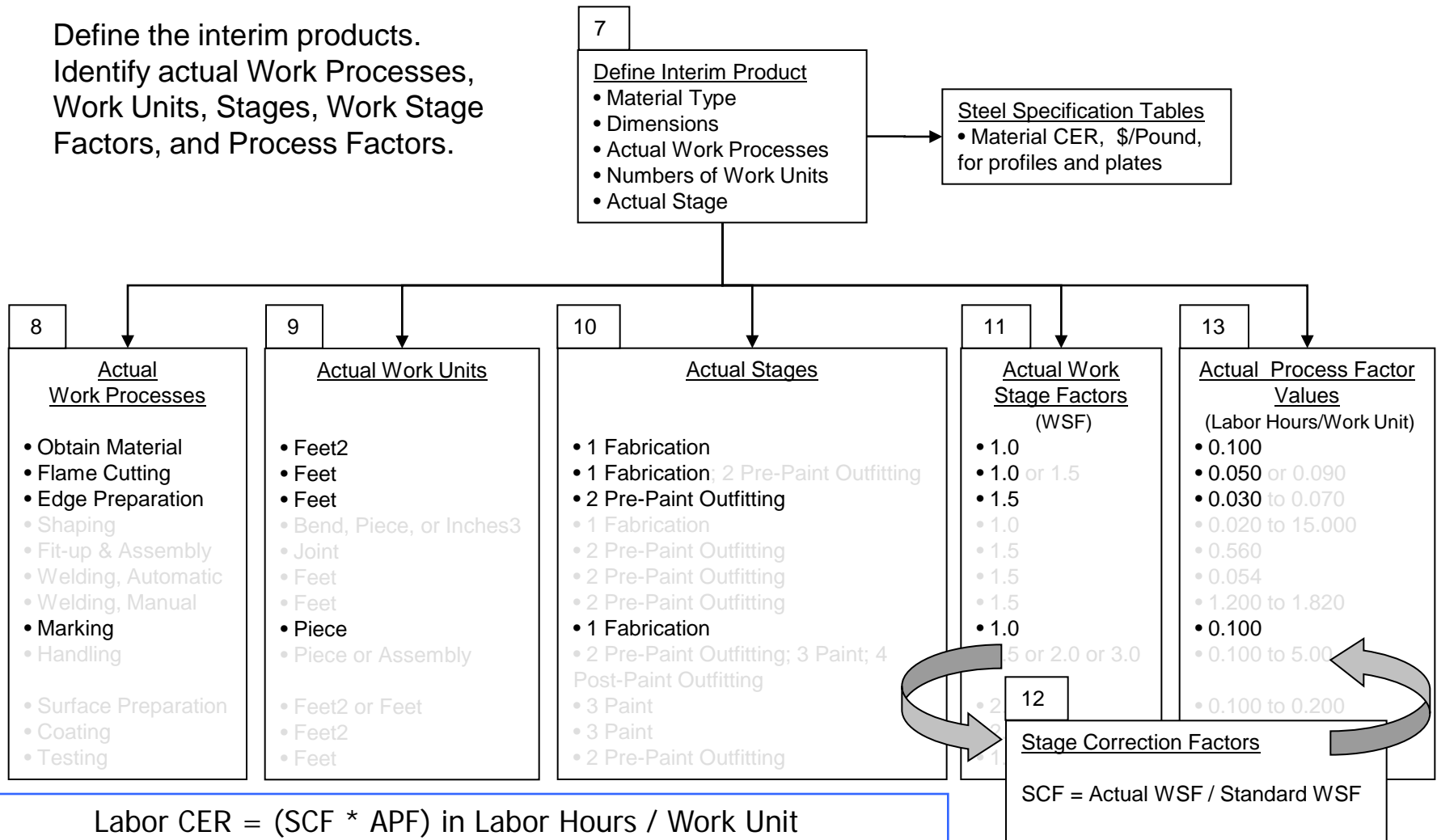
# The Procedure for Generating Product CERs



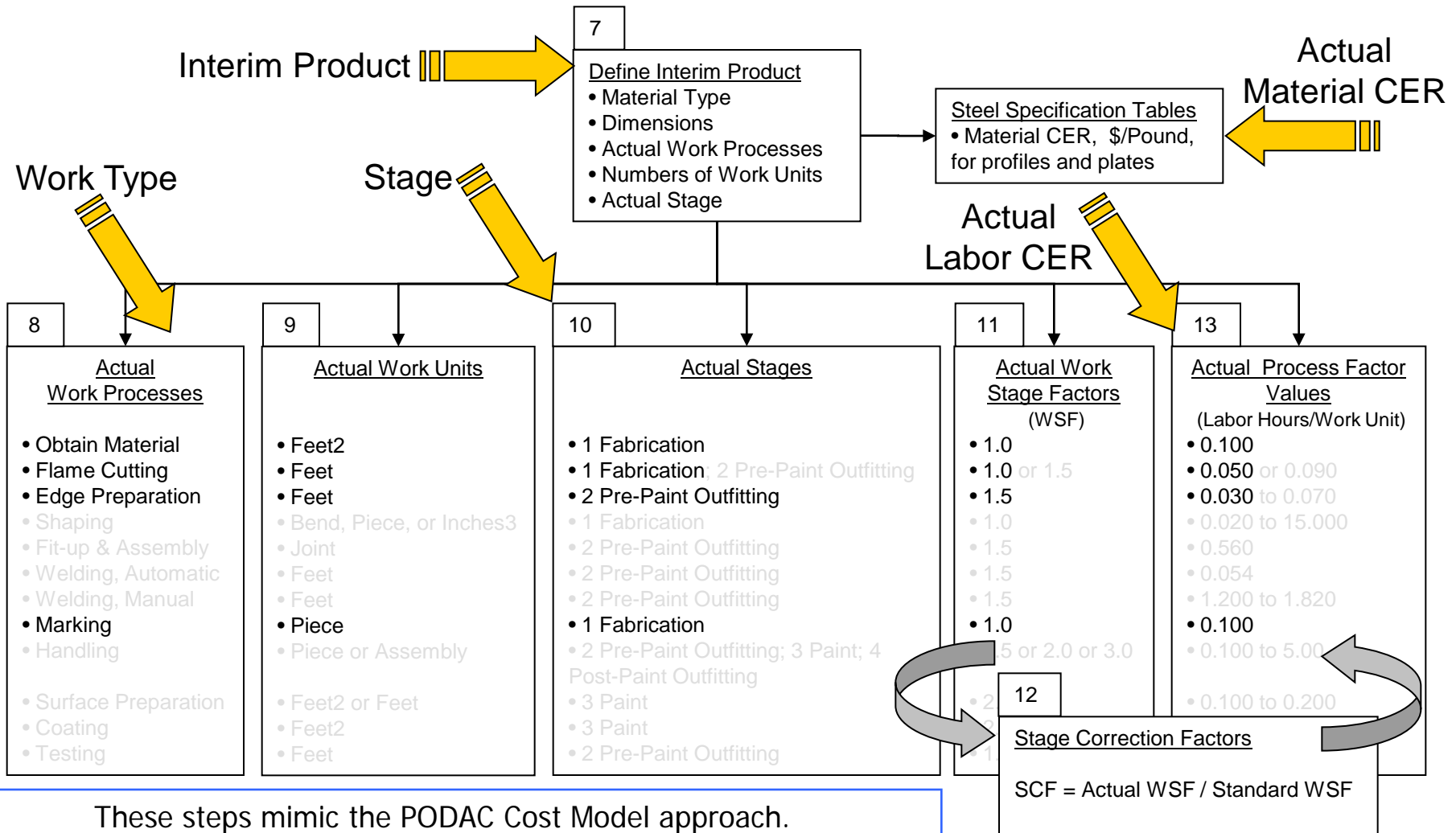
The procedure mimics the PODAC Cost Model approach.

# The Procedure for Generating Structural Product CERs

Define the interim products.  
Identify actual Work Processes,  
Work Units, Stages, Work Stage  
Factors, and Process Factors.

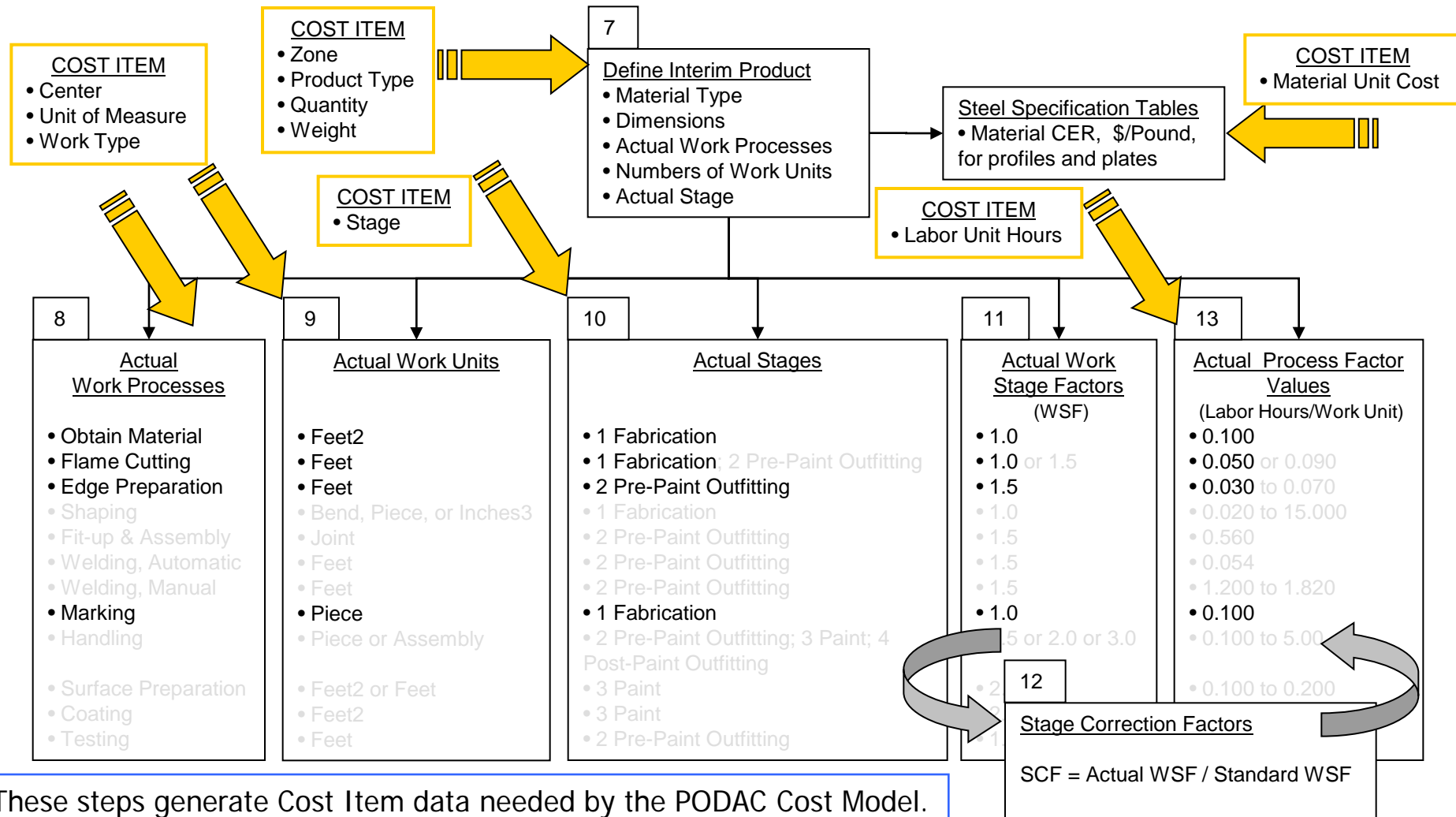


# The Procedure for Generating Structural Product CERs





# The Procedure and the PODAC Cost Model



# Returning to the Standard Procedure.....

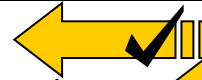
## **1. Define the Product to be Built (Mandatory)**

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## **2. Define How the Product will be Built (Mandatory.)**

- 2.1. Determine the Work Types.
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## **3. Define the Cost Information (Mandatory)**

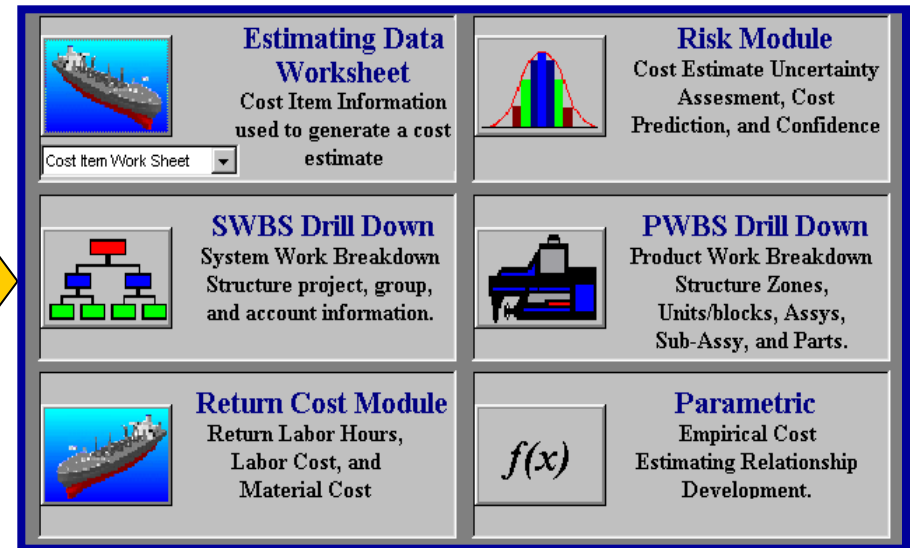
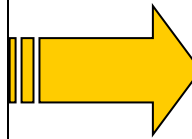
- 3.1. Determine the direct labor rates.

The standard procedure is now implementable within the PODAC Cost Model.

# What This Effort Really Accomplished

## The PODAC Cost Model

A Procedure for  
Generating  
Product-Based CERs  
Based on NSRP  
Funded Work.



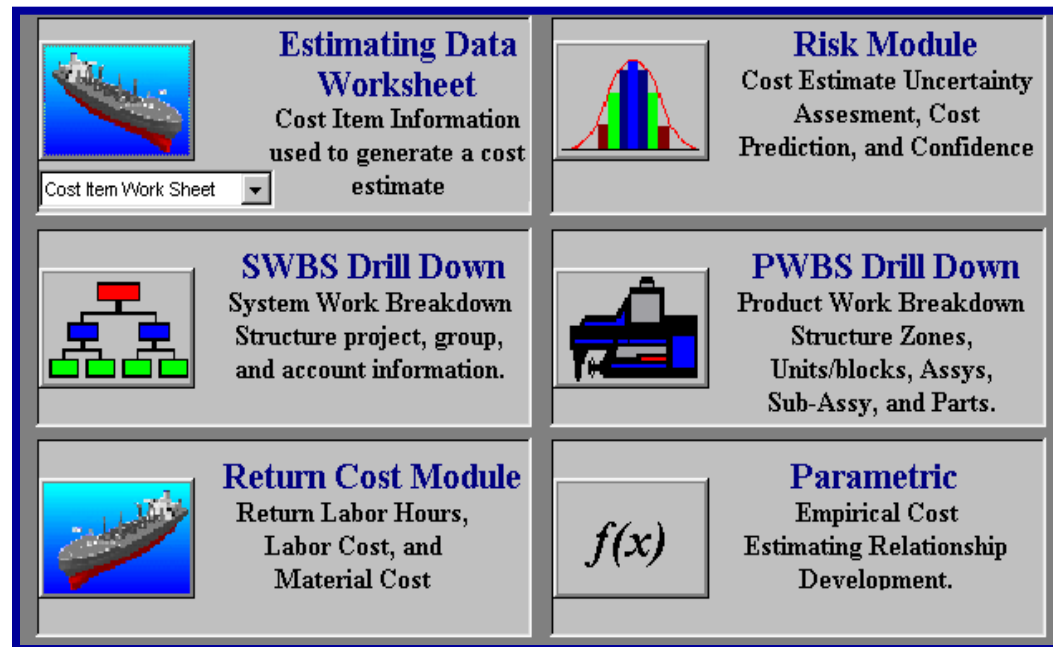
The standard procedure supports and enables the PODAC Cost Model.

# Demonstration - Example

- ⌘ Baseline: A fabrication cost estimate is made of a simple steel structure Assembly, a tee-stiffened steel plate.
- ⌘ Tradeoff #1:
  - ☒ Add a Maintenance Stage consisting of two (fabrication) Work Processes: "Surface Preparation - Blasting" and "Coating."
  - ☒ Re-blasting and re-painting required twice in a six-year period.
- ⌘ Tradeoff #2:
  - ☒ Four bulb-stiffeners are substituted for every two tee-stiffeners.
  - ☒ Unit cost of the bulb-stiffeners is 75% greater than tee-stiffeners.
  - ☒ Blasting and painting of the bulb-stiffeners requires 50% less labor than the tee-stiffeners.
  - ☒ Re-blasting and re-painting are not required over the six-year period.
- ⌘ Compare the costs of the Baseline, Tradeoff #1, and Tradeoff #2.

The PODAC Cost Model is flexible and tradeoffs are easy to perform.

# Using the PODAC Cost Model



This is the PODAC Cost Model opening screen.

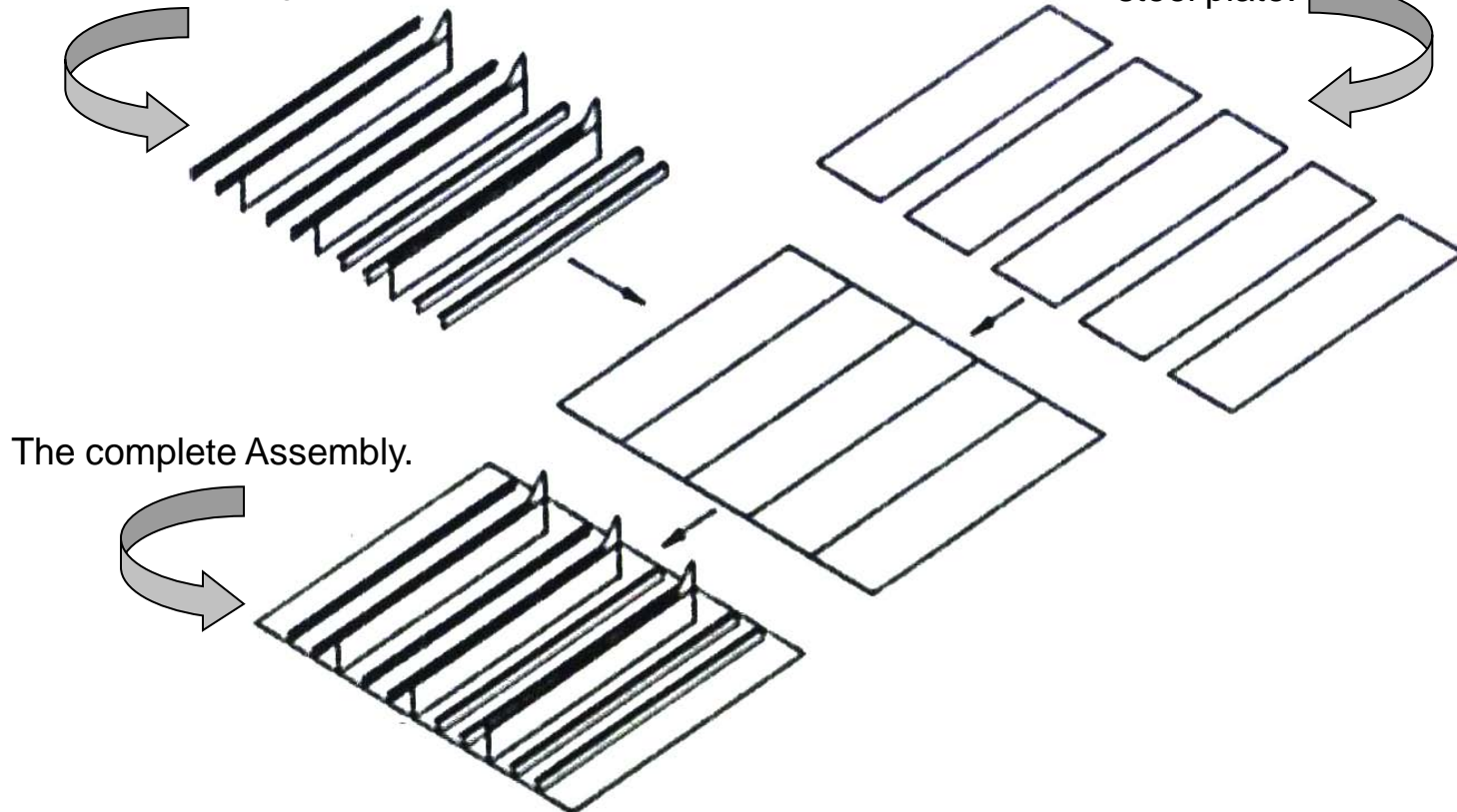
# Defining the Product

## (Tee-Stiffened Panel Assembly)

Three WT 12 X 30.5 Straight Profiles with End Gussets

Eight WT 4 X 7.5 Straight Profiles

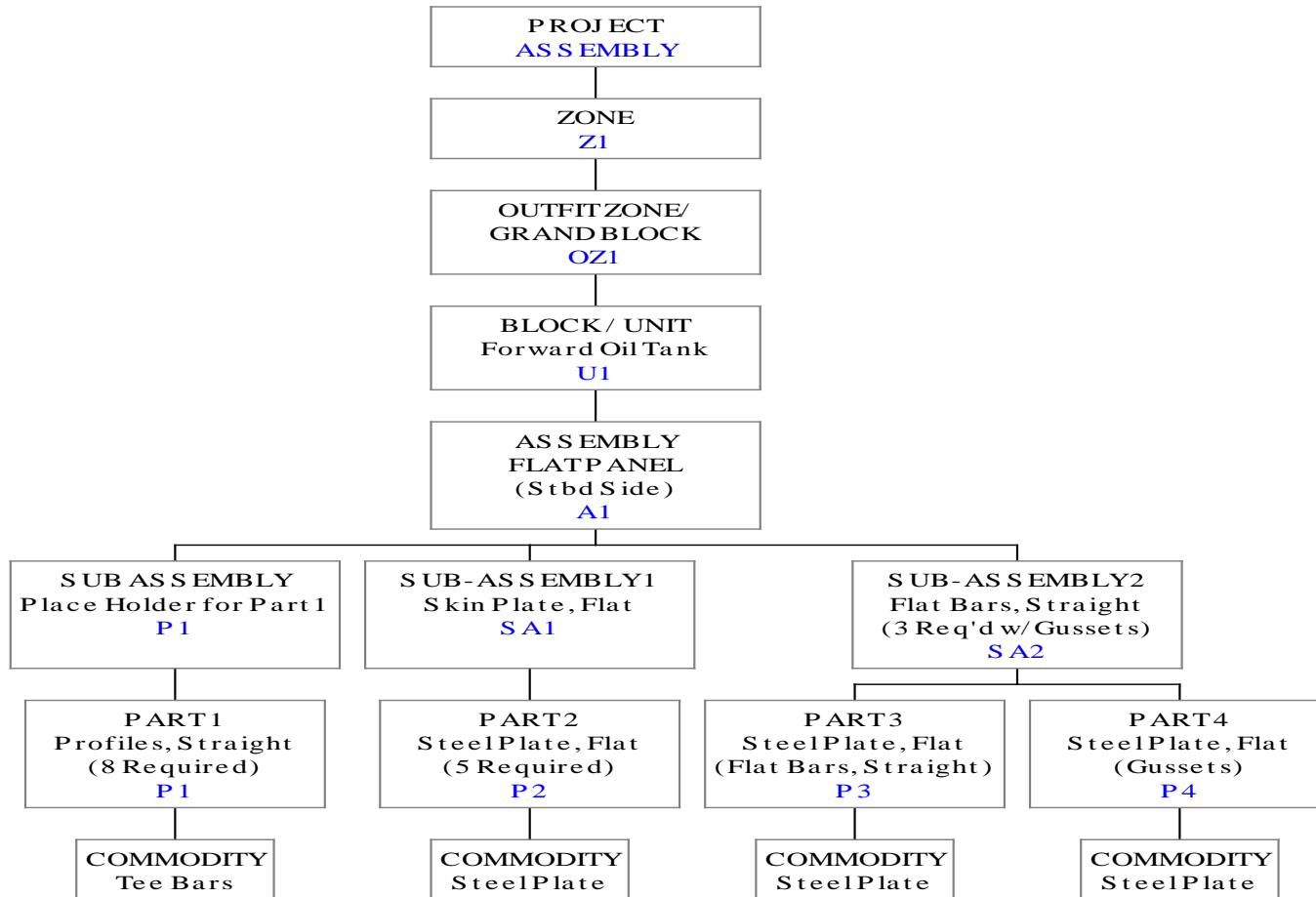
Five flat steel plates, butt-welded together to form one large flat steel plate.



This is the Assembly we modeled in the PODAC Cost Model.

# Defining The Product

(Tee-Stiffened Panel PWBS)

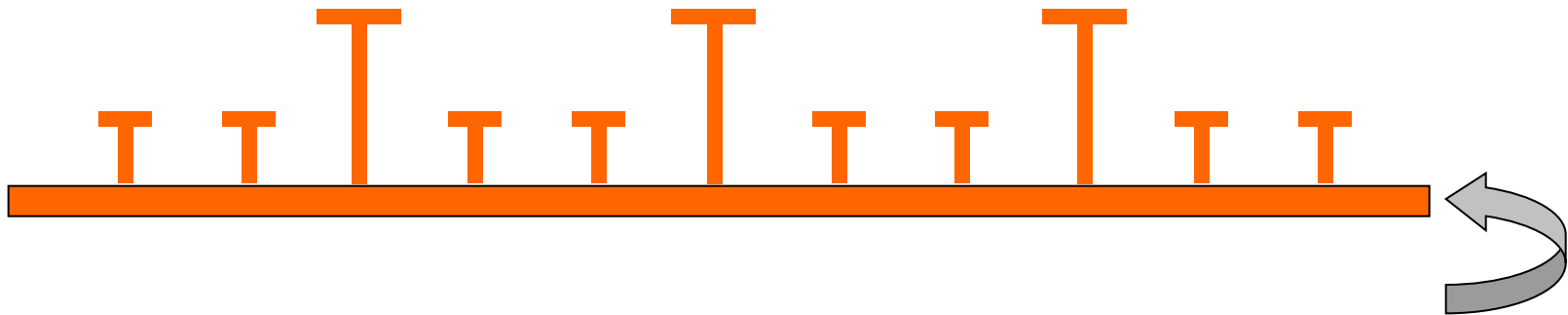


This is the Product Work Breakdown Structure of the Assembly.

# Defining The Product

(Concentrate on the Steel Flat Plates)

Baseline: Tee-Stiffened Plate



Consists of 5, flat steel plates,  
butt-welded together to form  
one large flat steel plate.

This is an end-view of the Assembly.



# Flat Steel Plate Interim Product

**Product:**    **PART 2, #1-5, Steel Plate, Flat**

**Location:**    **Hold Material**

## **Commodity Description**

<b><u>Item</u></b>	<b><u>Value Used</u></b>	<b><u>Data Source</u></b>
Material:	Steel	MIT, Table 4-2
Material:	MIL-S-22698 Grade DH-36	MIT, Table 4-2
Density, Pound / Inch <sup>3</sup>	0.278	Calculated
Density, Pound / Feet <sup>3</sup>	480.00	Calculated
Thickness, Inches:	0.50	MIT, Table 4-2
Thickness, Feet:	0.0417	Calculated
\$ / Pound:	\$0.45	MIT, Table 4-2
Pre-Cut Dimensions		
Length, Meters:	11.06	NSRP 0406, Table C6.1
Width, Meters:	2.29	NSRP 0406, Table C6.1
Area, Meters <sup>2</sup>	25.33	Calculated
Length, Feet:	36.29	Calculated
Width, Feet	7.51	Calculated
Area, Feet <sup>2</sup>	272.62	Calculated
Weight, Pounds	5,452	Calculated
Cost, \$	\$2,453.60	
Cut Dimensions		
Length, Feet:	30.00	Calculated
Width, Feet	6.00	Calculated
Area, Feet <sup>2</sup>	180.00	Calculated
Weight, Pounds	3,600	Calculated
Cost, \$	\$1,620.00	Calculated

Interim product definition: the flat steel plate.

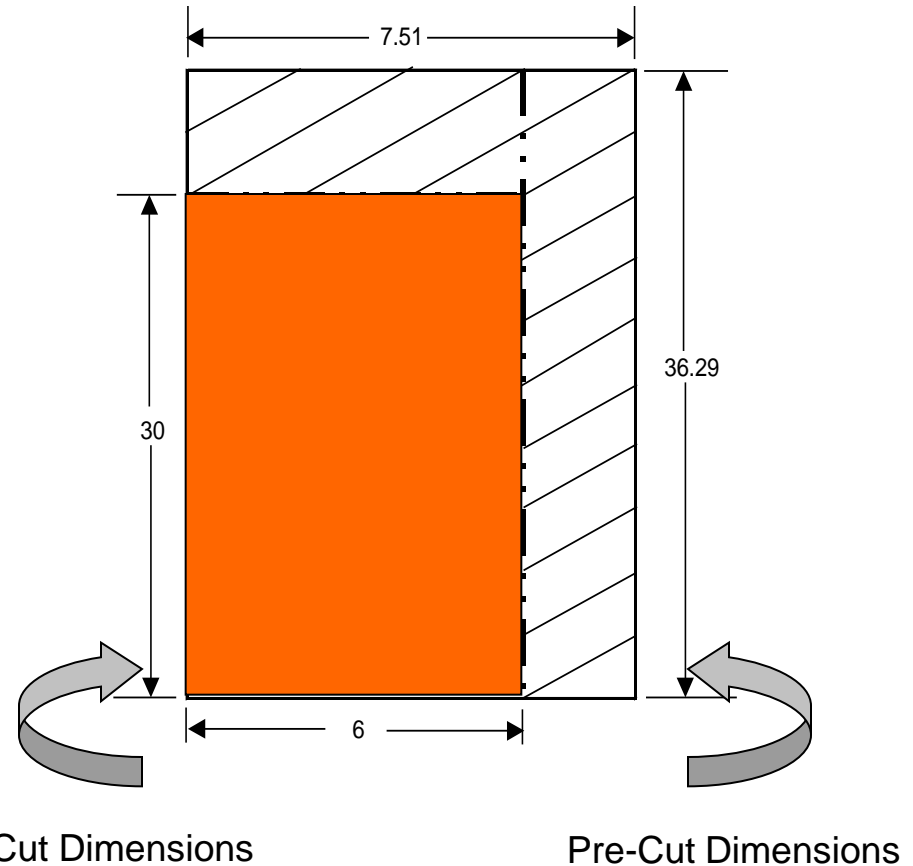
# Flat Steel Plate Interim Product

## Labor Required Work Processes:

1. Obtain Material: 545 Feet<sup>2</sup>
2. Flame Cut to size: 37.8 Feet
3. Edge Preparation: 72.0 Feet
4. Mark for inventory control: 1 Piece

## Material:

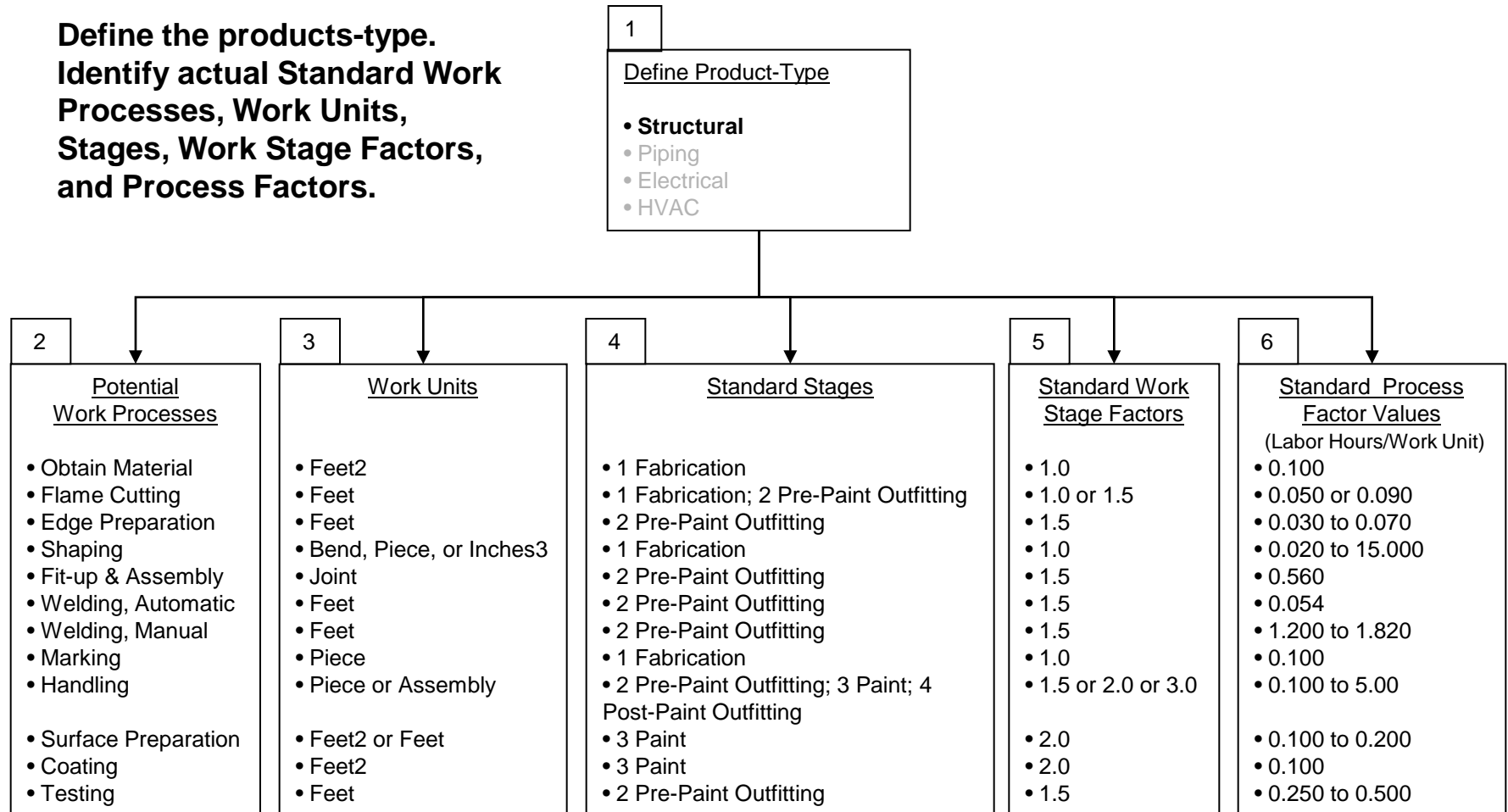
Mild Steel: 0.50 Inch Thick  
CER = \$0.45 / Pound @ 5,452 Pounds



Interim product definition: the flat steel plate.

# Setting up the Generic Procedure for Generating CERs

**Define the products-type.  
Identify actual Standard Work  
Processes, Work Units,  
Stages, Work Stage Factors,  
and Process Factors.**



The generic process is for a structural product-type.

# Setting Up Work Centers to Equal Work Processes

\$ ESTI-MATEplus Cost Model

File Edit Library Global Mods Reports DataBase Window Help



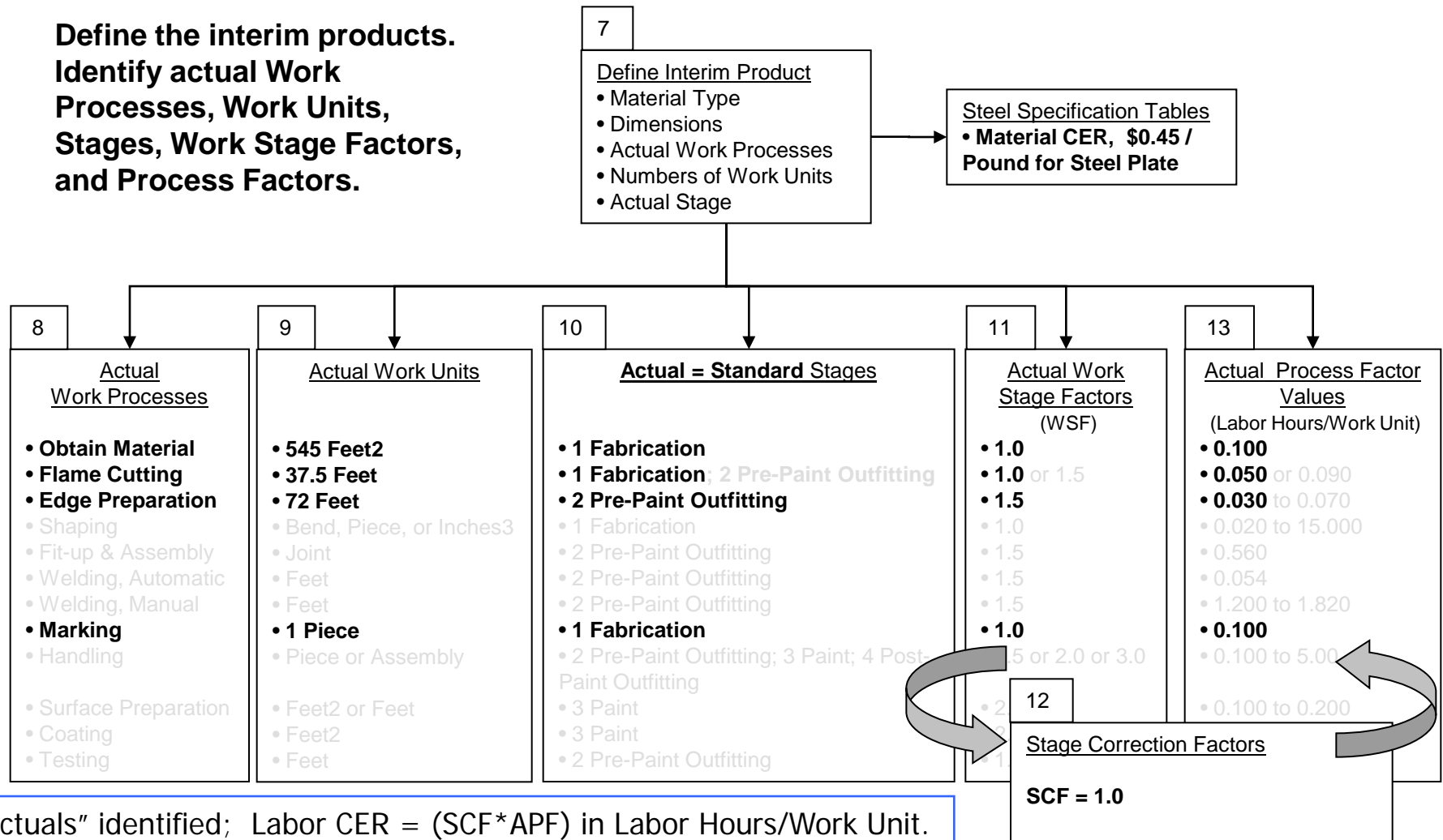
\$ Rate Tables and Indirect Formulas

	Contract ID	Project	Work Center	Description and Comments
<input checked="" type="checkbox"/>	1 Structural Steel	Assembly	SS1.1	obtain material - receipt & prep
	2 Structural Steel	Assembly	SS10.1	surface prep - blasting
	3 Structural Steel	Assembly	SS10.2	surface prep - grinding
	4 Structural Steel	Assembly	SS11.1	coating
	5 Structural Steel	Assembly	SS2.1	flame cutting - automatic
	6 Structural Steel	Assembly	SS2.2	flame cutting - manual
	7 Structural Steel	Assembly	SS3.1	edge prep grinding - flat
	8 Structural Steel	Assembly	SS3.2	edge prep grinding - vertical
	9 Structural Steel	Assembly	SS3.3	edge prep grinding - overhead
	10 Structural Steel	Assembly	SS4.1	shaping - break
	11 Structural Steel	Assembly	SS4.2	shaping - rolling
	12 Structural Steel	Assembly	SS4.3	shaping - line heating
	13 Structural Steel	Assembly	SS4.4	shaping - furnace
	14 Structural Steel	Assembly	SS4.5	shaping - press

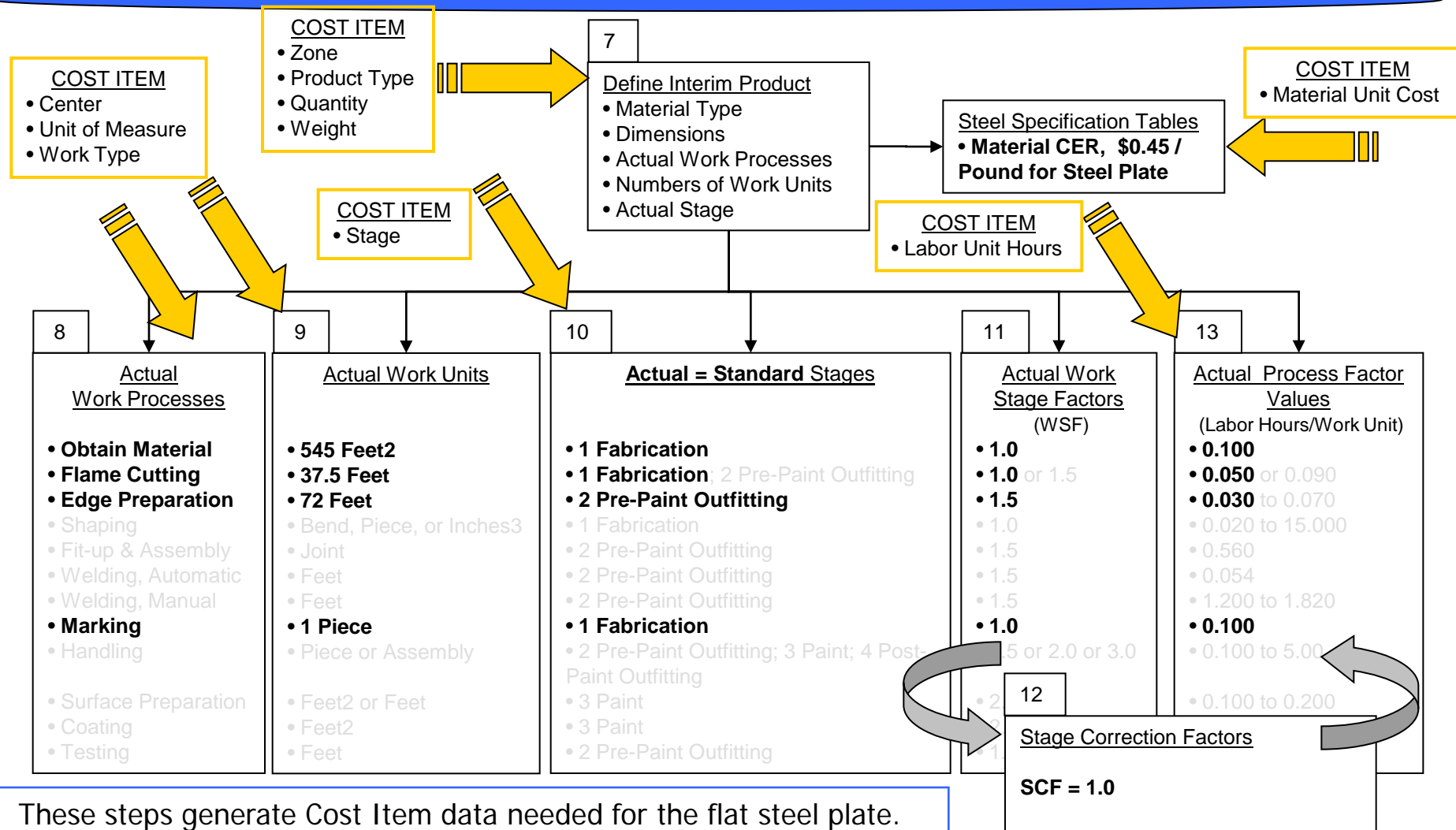
Work Centers and Rate Tables mimic the structural Work Processes.

# Applying the Procedure to Estimate Flat Steel Plate CERs

**Define the interim products.  
Identify actual Work  
Processes, Work Units,  
Stages, Work Stage Factors,  
and Process Factors.**



# Generating PODAC Cost Model Input for the Flat Steel Plates



# "Cost Items" for the Five Flat Steel Plates

**ESTI-MATEplus Cost Model**

File Edit Library Global Mods Reports DataBase Window Help

**Cost Items for MFG Part: P2**

**Item: 1 WBS Info**

Contract Id  
Structural Steel

Project Assembly

Center SS1.1

Cost Code

Account

Zone Z1

Outfit Zone OZ1

Unit/Block U1

Assembly A1

Sub Assy SA1

Mfg Part P2

CLIN

SWLIN - -

Paragraph

	Description	Quantity	Uom	Labor Unit Hours	Material Unit Cost (CER)	Sub Unit Hours (CER)	Travel Unit Cost (CER)	Total Labor Hours	Total Material Cost	Total Hour
<input checked="" type="checkbox"/>	1 P2-obtain material - plates (36.29'x7.51'x.5")	5.00	EA	54.5000	2453.6000	0.0000	0.00	272.50	12,268.00	
	2 P2-flame cut to size - auto - plates (30'x6') (Note to minimize cut	5.00	EA	1.8750	0.0000	0.0000	0.00	9.38	0.00	
	3 P2-mark each piece to facilitate identification steel plates	5.00	EA	0.1000	0.0000	0.0000	0.00	0.50	0.00	
	4 P2-edge Preparation - flat (grind 4 sides per unit) - steel plates	5.00	EA	2.8800	0.0000	0.0000	0.00	14.40	0.00	

**Item: 1 Origin Info** Labor CER 54.5000 Mat'l CER 2,453.6000

MANUAL This item was developed manually

Ready Using 1998 Rates 03 Sep 98 3:40 pm

Start Inbox - ... (D:) Microsoft... Files - M... SPAR Briefs Microsoft... Microsoft... ESTI-...

3:40 PM

# Options for Units of Measure vs Quantity

<u>Interim Product Situation</u>	<u>Option #1</u>	<u>Option #2, Labor</u>	<u>Option #2, Material</u>
Description	One or more, identical interim products	Unique, interim product	Unique, or more than one identical, interim products
Labor and/or Material Cost Item?	Labor and Material	Labor	Material
<u>COST ITEM Worksheet Variable</u>	(1)	(2)	(1)
Uom (Unit of Measure)	Each	Feet2	Each
Quantity	Total number of identical, interim products	Numer of Feet2 for the unique, interim product	Total number of identical, interim products
Labor Unit Hours (CER)	Hours / Each (3)	Hours / Feet2 (4)	NA
Material Unit Cost (CER)	\$ / Each (1)	NA	\$ / Each (1)

(1) Each = per unit, per pound, or per any other dimension of interest.

(2) Feet2 is a typical unit of measure.

(3) Hours / Each = (Feet2 / Each) \* (Hours / Feet2)

(4) (Hours / Feet2) is the Actual Process Factor

Optional methods exist for using Units of Measure and Quantity.



# "Cost Items" for Joining the Five Flat Steel Plates

**ESTI-MATEplus Cost Model**

File Edit Library Global Mods Reports DataBase Window Help

**Cost Items for Sub Assembly: SA1**

Item: 1 WBS Info		Description	Quantity	Uom	Labor Unit Hours (CER)	Material Unit Cost (CER)	Sub Unit Hours (CER)	Travel Unit Cost	Total Labor Hours	Total Material Cost	Total Sub Hour
Contract Id	Structural Steel										
Project	Assembly	1 P2-obtain material - plates (36.29'x7.51'x.5")	5.00	EA	54.5000	2453.6000	0.0000	0.00	272.50	12,268.00	0.
Center	SS1.1	2 P2-flame cut to size - auto - plates (30'x6') (Note to minimize cutting)	5.00	EA	1.8750	0.0000	0.0000	0.00	9.38	0.00	0.
Cost Code		3 P2-mark each piece to facilitate identification steel plates	5.00	EA	0.1000	0.0000	0.0000	0.00	0.50	0.00	0.
Account		4 P2-edge Preparation - flat (grind 4 sides per unit) - steel plates	5.00	EA	2.8800	0.0000	0.0000	0.00	14.40	0.00	0.
Zone	Z1	5 SA1-mark sub-assembly to facilitate identification	1.00	EA	0.1000	0.0000	0.0000	0.00	0.10	0.00	0.
Outfit Zone	OZ1	6 SA1-fit up & assembly	4.00	EA	16.8000	0.0000	0.0000	0.00	67.20	0.00	0.
Unit/Block	U1	7 SA1-welding, Auto/Machine - Fillet	4.00	EA	14.4000	0.0000	0.0000	0.00	57.60	0.00	0.
Assembly	A1										
Sub Assy	SA1										
Mfg Part	P2										
CLIN											
SWLIN	- -										
Paragraph											

**Item: 1 Origin Info** Labor CER 54.5000 Mat'l CER 2,453.6000

MANUAL This item was developed manually

Enter the description.

Using 1998 Rates 03 Sep 98 3:03 pm

Start Inbox - ... (D:) Microso... Files - ... SPAR PODAC... Briefs Microso... Microso... ESTI...

3:03 PM

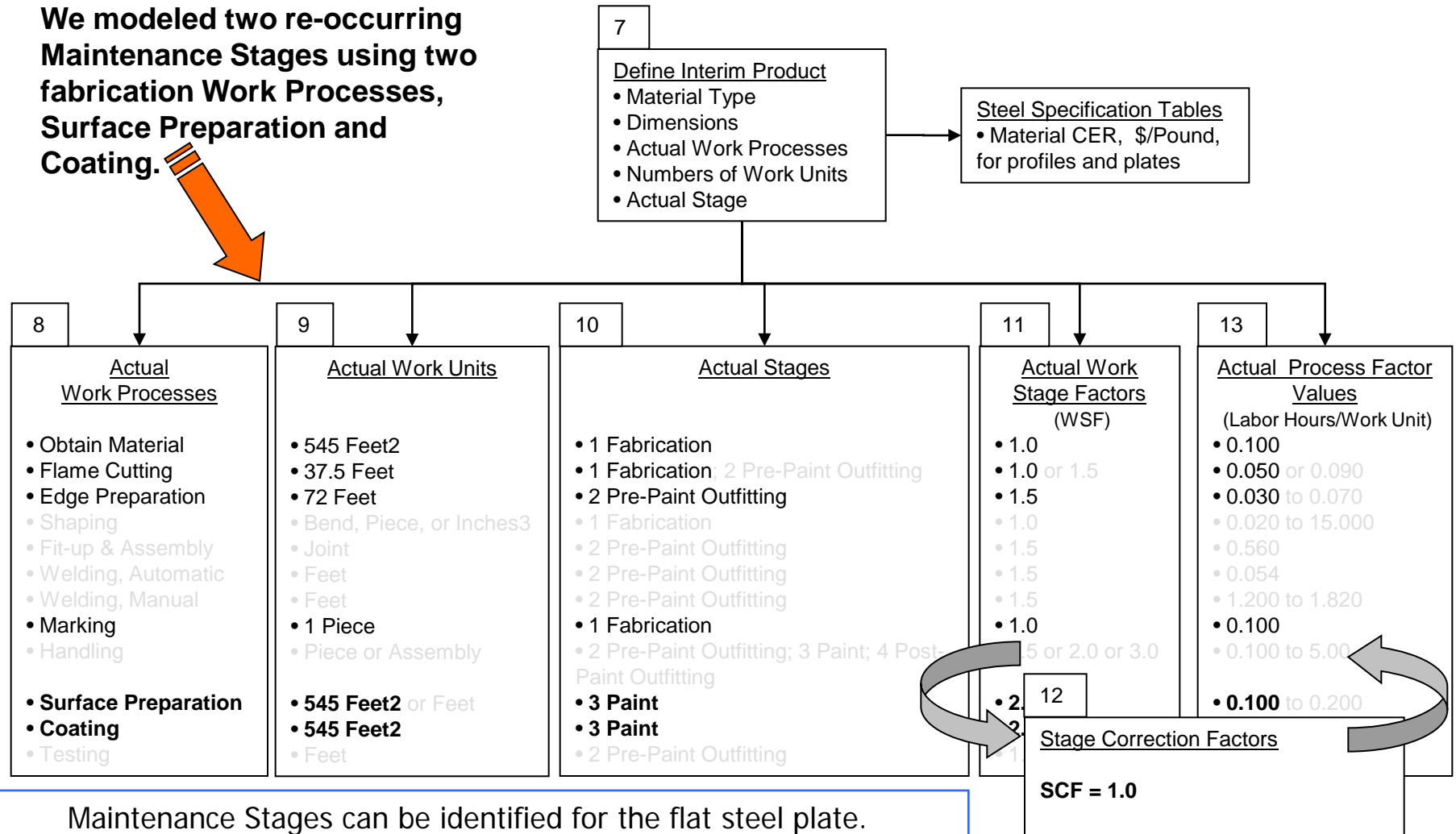
The image shows the top portion of the ESTI-MATEplus software interface. At the top is a dark blue title bar with the text "\$ ESTI-MATEplus Cost Model". Below the title bar is a menu bar with the following items: File, Edit, Library, Global Mods, Reports, DataBase, Window, and Help. Underneath the menu bar is a toolbar containing various icons for file operations (like Open, Save, Print), editing (like Undo, Redo), and navigation (like Previous, Next). The interface is designed for managing cost models and reports.

Ready Using 1998 Rates 09 Sep 98 1:04 pm

Start Inbox - Mic... (D:) Microsoft ... RE: have ... Navy Progr... Netscape ... ESTI-M... SPAR 1:04 PM

# Tradeoff #1: Typical Adding of Maintenance "Stages"

We modeled two re-occurring Maintenance Stages using two fabrication Work Processes, Surface Preparation and Coating.

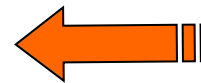


# More Thoughts on Adding Maintenance Stages

Level	Stage of Construction	Location	Standard Difficulty Factor
1	Fabrication	In Shop	1
2	Pre-Paint Outfitting	On Plate Line Hot Work	1.5
3	Paint	Paint Shop / Stage	2
4	Post-Paint Outfitting	On Platen - Cold Work	3
5	Erection	Erection Site	4.5
6	On-Board Outfitting	Erection Site	7
7	Waterborne	Pierside After Launch	10

**We modeled the two re-occurring Maintenance Stages, Surface Preparation and Coating, using Level 3 Standard Difficulty Factors.**

**Perhaps, we should have used Level 5 or 6.**



More considerations should be given to the addition of Maintenance Stages.

# The Baseline and Tradeoff #1

## Study Results

**ESTI-MATEplus Cost Model**

File Edit Library Global Mods Reports DataBase Window Help

**View Report**

### Project Summary by Contract

Contract Id		9-Sep-98										Page 1 of 1	
Project	Description	Labor Hours	Labor Cost	Material Cost	Sub Con Hours	Sub Con Cost	Travel Cost	Direct Cost	Taxes	Indirect Cost	Total Cost	Profit	Total Price
Assembly	Product Breakdown Structure Exas	1,440	28,791	15,444	0	0	0	44,235	0	40,307	84,543	0	84,543
TO1	Trade Off - Tee stiffeners w/2 yr.	2,823	56,463	15,444	0	0	0	71,907	0	79,048	150,955	0	150,955

<u>Tee-Stiffened Baseline</u>		<u>Baseline w Maintenance</u>
Labor \$ =	\$28,791	\$56,463
Material \$ =	\$15,444	\$15,444
Indirect \$ =	\$40,307	\$70,048
 Total \$ =	 \$84,543	 \$150,955

**We added two re-occurring Maintenance Stages, Surface Preparation and Coating, using fabrication Work Processes and Level 3 Standard Difficulty Factors, and we need to re-painting twice in the first six years.**

# Tradeoffs: Changing the Product and the Assumptions

Baseline: Tee-Stiffened Plate



⌘ Baseline: steel structure Assembly, a tee-stiffened steel plate.

⌘ Tradeoff #1:

- ⏏ Add a Maintenance Stage: "Surface Preparation - Blasting" and "Coating."
- ⏏ Re-blasting and re-painting required twice in a six-year period.

Tradeoff: Bulb-Stiffened Plate



⌘ Tradeoff #2:

- ⏏ Four bulb-stiffeners are substituted for every two tee-stiffeners.
- ⏏ Unit cost of the bulb-stiffeners is 75% greater than tee-stiffeners.
- ⏏ Blasting and painting of the bulb-stiffeners requires 50% less labor than the tee-stiffeners.
- ⏏ Re-blasting and re-painting are not required over the six-year period.

The structural details and the maintenance needs/philosophy change for Tradeoff #2.

# "Cost Items" for the Bulb-Stiffeners

**ESTI-MATEplus Cost Model**

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**Cost Items for MFG Part: P1**

Item: 1 WBS Info	Description	Quantity	Uom	Labor Unit Hours (CER)	Material Unit Cost (CER)	Sub Unit Hours (CER)	Travel Unit Cost (CER)	Total Labor Hours	Total Material Cost	Total Sub Hours	Tot Trav Co
Contract Id Structural Steel											
Project TO2	1 P1-edge preparation - flat - 16	16.00	EACH	1.2000	0.0000	0.0000	0.00	19.20	0.00	0.00	
Center SS3.1	2 P1-flame cut, auto - 16 bulb p	16.00	EACH	0.0350	0.0000	0.0000	0.00	0.56	0.00	0.00	
Cost Code	3 P1-marking - 16 bulb profiles	16.00	EACH	0.1000	0.0000	0.0000	0.00	1.60	0.00	0.00	
Account	4 P1-obtain, receipt and prep	16.00	EACH	4.8900	142.8700	0.0000	0.00	78.24	2,285.92	0.00	
Zone Z1											
Outfit Zone OZ1											
Unit/Block U1											
Assembly A1											
Sub Assy P1											
Mfg Part P1											
CLIN											
SWLIN - -											
Paragraph											

**Item: 1 Origin Info** Labor CER 1.2000 Mat'l CER 0.0000

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# "Cost Item" Summary for the Assembly

**ESTI-MATEplus Cost Model**

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**Cost Items for Assembly: A1**

Item: 1 WBS Info	Description	Quantity	Uom	Labor Unit Hours (CER)	Material Unit Cost (CER)	Sub Unit Hours (CER)	Travel Unit Cost (CER)	Total Labor Hours	Total Material Cost	Total Sub Hours
Contract Id Structural Steel	1 P1-edge preparation - flat - 8	8.00	EACH	1.2000	0.0000	0.0000	0.00	9.60	0.00	0.00
Project Assembly	2 SA2-welding - manual - fillet	3.00	EACH	1.0200	0.0000	0.0000	0.00	3.06	0.00	0.00
Center SS3.1	3 P2-obtain material - plates (3	5.00	EACH	54.5000	2453.6000	0.0000	0.00	272.50	12,268.00	0.00
Cost Code	4 P2-flame cut to size - auto - p	5.00	EACH	1.8750	0.0000	0.0000	0.00	9.38	0.00	0.00
Account	5 P2-mark each piece to facilita	5.00	EACH	0.1000	0.0000	0.0000	0.00	0.50	0.00	0.00
Zone Z1	6 P4-flame cutting, auto - 3 gu	3.00	EACH	0.0950	0.0000	0.0000	0.00	0.29	0.00	0.00
Outfit Zone OZ1	7 P3-Flame cutting, Auto - 3 T	3.00	EACH	0.0800	0.0000	0.0000	0.00	0.24	0.00	0.00
Unit/Block U1	8 P3-marking - Tee Bars	3.00	EACH	0.1000	0.0000	0.0000	0.00	0.30	0.00	0.00
Assembly A1	9 A1-fit up and assembly - 3 p	3.00	EACH	16.8000	0.0000	0.0000	0.00	50.40	0.00	0.00
Sub Assy P1	10 A1-welding, auto / machine	3.00	EACH	4.2000	0.0000	0.0000	0.00	12.60	0.00	0.00
Mfg Part P1	11 P2-edge Preparation - flat (g	5.00	EACH	2.8800	0.0000	0.0000	0.00	14.40	0.00	0.00
CLIN	12 SA1-mark sub-assembly to f	1.00	EACH	0.1000	0.0000	0.0000	0.00	0.10	0.00	0.00
SWLIN	13 A1-marking - A1	1.00	EACH	0.1000	0.0000	0.0000	0.00	0.10	0.00	0.00
Paragraph	14 SA1-fit up & assembly	4.00	EACH	16.8000	0.0000	0.0000	0.00	67.20	0.00	0.00
	15 SA1-welding, Auto/Machine	4.00	EACH	14.4000	0.0000	0.0000	0.00	57.60	0.00	0.00
	16 P3-obtain material - Tee Bars	3.00	EACH	11.4000	841.1100	0.0000	0.00	34.20	2,523.33	0.00
	17 SA2-marking SA2	3.00	EACH	0.1000	0.0000	0.0000	0.00	0.30	0.00	0.00

**Item: 1 Origin Info** Labor CER 1.2000 Mat'l CER 0.0000

MANUAL This item was developed manually

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# The Baseline, Tradeoff #1, and Tradeoff #2 Study Results

ESTI-MATEplus Cost Model													
View Report													
Project Summary by Contract													
Contract Id Structural Steel - Starboard Panel of Forward Oil Tank on Container Ship using b										9-Sep-98		Page 1 of 1	
Project	Description	Labor Hours	Labor Cost	Material Cost	Sub Con Hours	Sub Con Cost	Travel Cost	Direct Cost	Taxes	Indirect Cost	Total Cost	Profit	Total Price
Assembly	Product Breakdown Structure Exam	1,440	28,791	15,444	0	0	0	44,235	0	40,307	84,543	0	84,543
TO1	Trade Off - Tee stiffeners w/2 yr.	2,823	56,463	15,444	0	0	0	71,907	0	79,048	150,955	0	150,955
TO2	Trade Off - 16 Bulb Stiffeners w/	1,311	26,229	17,077	0	0	0	43,306	0	36,721	80,027	0	80,027
Contract: Structural Steel Totals		5,574	111,483	47,966	0	0	0	159,449	0	156,076	315,525	0	315,525

Tee-Stiffened Baseline				Baseline w Maintenance				Bulb-Stiffened w New Maintenance			
Labor \$ =		\$28,791		\$56,463				\$26,299			
Material \$ =		\$14,444		\$15,444				\$17,077			
Indirect \$ =		\$40,307		\$70,048				\$36,721			
Total \$ =		\$84,543		\$150,955				\$80,027			



We used bulb-stiffeners and we never need to re-paint in the first six years.

# Summary, Conclusions, and Recommendations

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## ⌘ Develop a Standard Procedure

### ☒ Summary

- ☒ PODAC Cost Model was related to UPA Cost Model.
- ☒ **A generic procedure was developed and a structural products procedure was developed.**
- ☒ **A process was defined for creating standard, work process, re-use packages for typical, fabricated, structural items.**
- ☒ **Procedures for piping systems, electrical systems, and hull ventilation and air conditioning systems were suggested.**
- ☒ **Procedures for outfitted structural products was suggested.**
- ☒ A cost tradeoff study was performed.

### ☒ Conclusions

- ☒ **The PODAC Cost Model can replicate the UPA Model.**
- ☒ **Without specific shipyard data, generic procedures can be developed for using the PODAC Cost Model.**
- ☒ **The Navy can use the PODAC Cost Model to perform comparative, relative, tradeoff studies.**

### ☒ Recommendations

- ☒ Incorporate typical spreadsheet capabilities.
- ☒ Refine the generic and structural product procedures.
- ☒ Create standard, work process, re-use packages typical, fabricated, structural items.
- ☒ Extend the generic procedure to piping systems, electrical systems, and hull ventilation and air conditioning systems.
- ☒ Integrating the structural product procedure with the distributed system procedures.
- ☒ Perform more PODAC Cost Model studies.

# Summary, Conclusions, and Recommendations

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## ⌘ Determine the Benefits

### ☒ Summary

- ☒ **It provides a new cost estimating capability.**
- ☒ **It estimates the cost of interim products according to the way in which they are fabricated.**
- ☒ It provides multiple views of a cost estimate including by Project, by PWBS, by Work Center, by Cost Item Value by Work Center, and by Cost Item Value by PWBS.
- ☒ **It is inherently flexible such that Maintenance Stages can be modeled; it is a life cycle cost model.**
- ☒ **It allows rapid cost, tradeoff studies and it provides a variety of cost sensitivity capabilities.**

### ☒ Conclusions

- ☒ Training and example problem experience are required.
- ☒ An understanding of several new issues is required.
- ☒ New databases are required.

### ☒ Recommendations

- ☒ Training should be offered and an illustrative, example problem set should be created.
- ☒ Training, supporting documentation, and databases should be made available.
- ☒ The concept of a "cost estimating system," with the PODAC Cost Model as a key feature of the system, should be explored.
- ☒ Enhancements to the model should be made: spreadsheet capability, construction sequence, schedule variations, dynamic feedback loops, and other manufacturing issues.